Space Weather Technical Forecast

Issued on Friday, 19 May 2023 at 13:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: R1/R2 Likely.

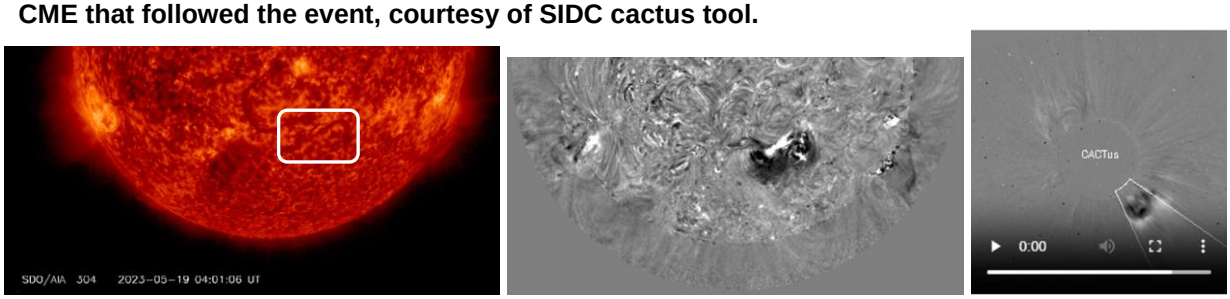
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with X-ray activity recorded at GOES16 showing several M-class flares, these mostly originating from AR3311. The largest was a M5.2 observed at 19/0048 UTC.

There are currently nine sunspot regions on the visible disc, one of which is has recently emerged in the southeast quadrant and is currently unnumbered. The largest and most complex region is AR3311, now classified as Eai/beta-gamma, due to an apparent increase in length. A delta spot may become apparent in its central part as the region progressively rotates westwards away from the eastern limb, revealing more details. AR3310 has consolidated its intermediate spots and is now classified as Cho/beta. AR3305 remains a complex region but has started to reduce in size, now classified as Dai/Beta. Of the remaining regions, including the new region that has recently emerged onto the southeast limb, most are small, weak and simple, with AR3301 now barely visible.

There have been various filament eruptions over the past 24 hours, and also prominence eruptions, these mainly from the NE limb or quadrant or far sided. A filament eruption that was seen leaving the sun on 17 May may give a slight glancing blow at Earth but confidence is low. Another filament eruption was seen leaving the sun early on 19 May, quickly followed by a CME. It may be Earth-directed but there are currently not enough satellite imagery to analyse it.

Figure 1. From left to right - SDO AIA 304 imagery showing the filament before it erupted; time-integrated AIA 211 dimming of the event, processing courtesy SIDC ROB; snapshot of the CME that followed the event, courtesy of SIDC cactus tool.



Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was suggestive of a slow solar wind regime. The solar wind speed was steady and around 460km/s according to DSCOVR, 350km/s according to ACE. The solar wind density remained in single figures ppcc. The IMF was weak and largely unchanged, between 4-6nT, while the north-south component ranged from +/-5nT and was mostly coaligned with the Earth's magnetic field. The phi angle was positive (away from the Sun) throughout.

The net result of the above solar wind measures was for Quiet (Kp 0-1) geomagnetic activity

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16 continued its slow decline in the wake of 16 May's M9.6 from AR3310, having peaked at 0.8pfu - i.e. roughly a decade below S1.

High energy electron flux (greater than 2MeV), as measured at GOES16 was at Normal Background levels. The 24-hour integrated fluence has been well below Active levels. At 19/0001UTC, 2.36e6 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Moderate with a Slight Chance of X-class throughout the period, AR3310 and AR3311 being the most likely sources of these flares. No significant regions leave the disc in the period, and no new large regions are expected to arrive, leading to a level risk throughout.

Solar Wind / Geomagnetic Activity: A filament eruption seen on the 17th from the southwest quadrant resulted in a CME, which has now been analysed with a potential Earth directed component arriving on the 21st. However, this CME is likely to be weak and any impacts to be modest. The solar wind is expected to remain at slightly elevated levels through much of the period, before increasing to 500-600km/s at the end of day 4 at the onset of the HSS associated with CH05/-.

Geomagnetic activity is expected to be largely Quiet to Unsettled overall, with a slight chance of Active periods (Kp 4) on day 3 (21st) following the expected CME's arrival.

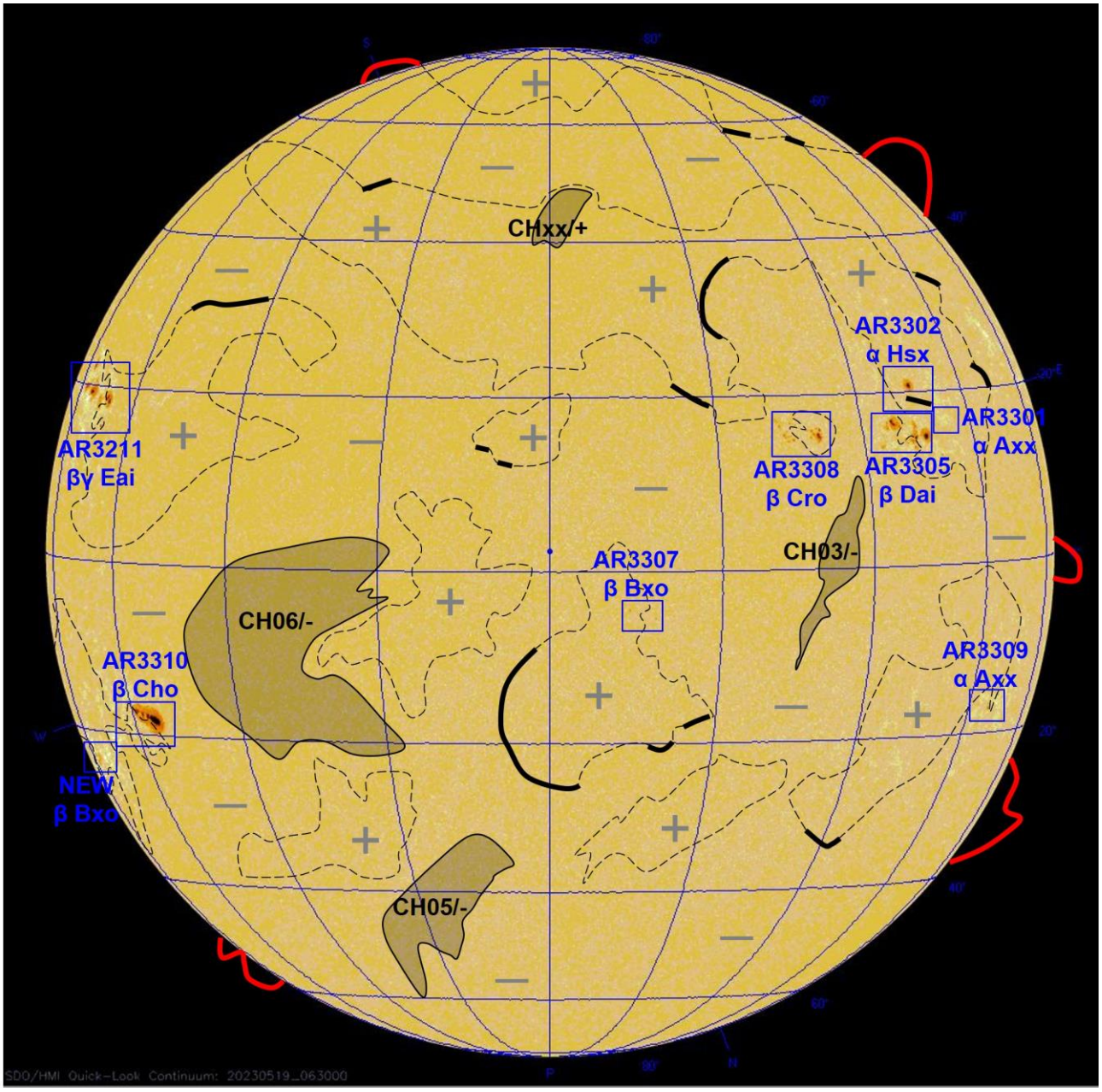
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux carries a daily Slight Chance of S1, largely as a result of the eastern hemisphere spots, with this very gradually rising over the four days.

High energy electron flux (greater than 2MeV) should most likely remain at Normal Background levels throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2. Solar Analysis Valid 19/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

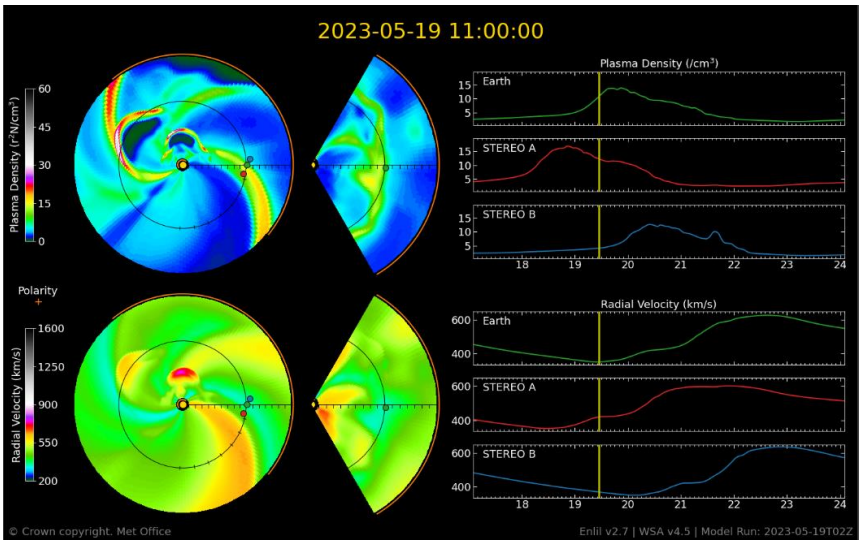
Geomagnetic Storms:
A filament eruption that was seen leaving the sun on 17 May may give a slight glancing blow at Earth on day 3 (21st). However this CME is likely to be weak and any impact very modest. Another filament eruption was seen leaving the sun early on 19 May. It may be Earth-directed but there are currently not enough satellite imagery to analyse it. Other various CMEs were observed from prominence and filaments eruptions but none of them are currently considered to be Earth directed.

There is only one possible source of fast wind in the four-day period, CH05/-, with its associated fast wind expected at the end of day 4. The minor coronal hole CH03/- is a recurrent feature however its influence was entirely masked by a CME-derived G4 during the past rotation and cannot be relied upon. The latest MOSWOC Enlil is most likely mirroring the arrival of the fast wind associated with the CME and the rise to 500-600 km/s is considered unlikely to happen before the end of day 4 (22nd).

Geomagnetic activity is expected to be largely Quiet to Unsettled overall, with a slight chance of Active periods (Kp 4) on day 3 (21st) following the expected CME's arrival.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 3: MOSWOC Enlil, whose rise is considered to mirror a CME that occurred on the past rotation.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

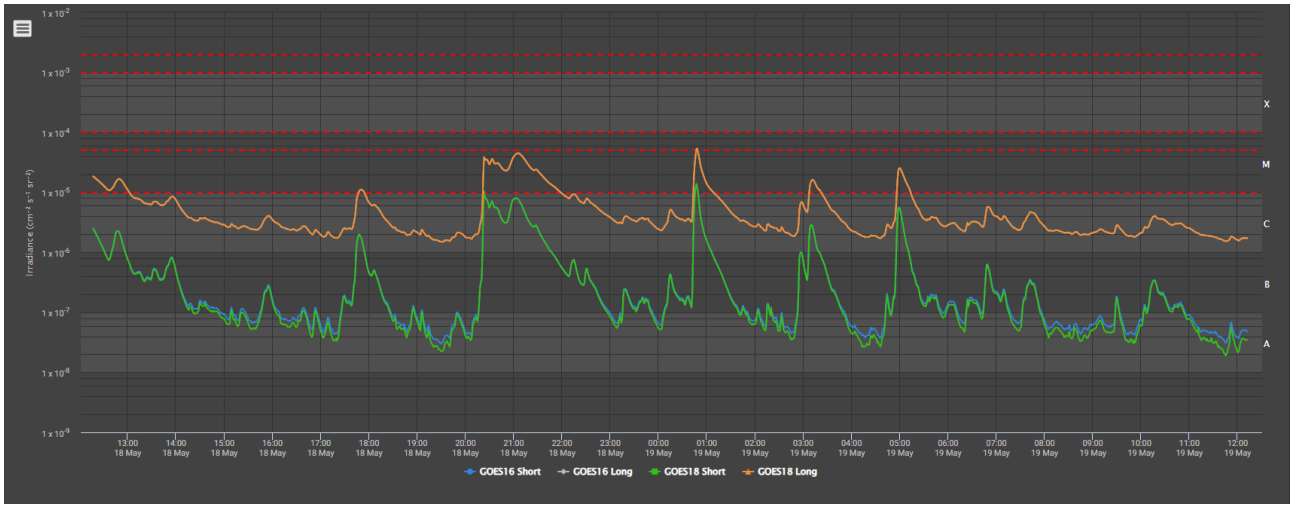
© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
There are currently nine sunspot regions on the visible disc, one of which is has recently emerged in the southeast quadrant and is currently unnumbered. The largest and most complex region is AR3311, now classified as Eai/beta-gamma, due to an apparent increase in length. A delta spot may become apparent in its central part as the region rotates further onto the visible disc but it is not yet clear. AR3310 has consolidated its intermediate spots and is now classified as Cho/beta. AR3305 remains a complex region but has started to reduce in size, now classified as Dai/Beta. Of the remaining regions, including the new region that has recently emerged onto the southeast limb, most are small, weak and simple, with AR3301 now barely visible.

Solar activity is expected to remain Moderate with a Slight Chance of X-class throughout the period, AR3310 and AR3311 being the most likely sources of these flares. No significant regions leave the disc in the period, and no new large regions are expected to arrive, leading to a level risk throughout.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	70	70	70	70
Very Active	**R3 to R5 X Class**	No	15	15	15	15

Figure 4: Latest GOES-16 X-ray flare activity



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

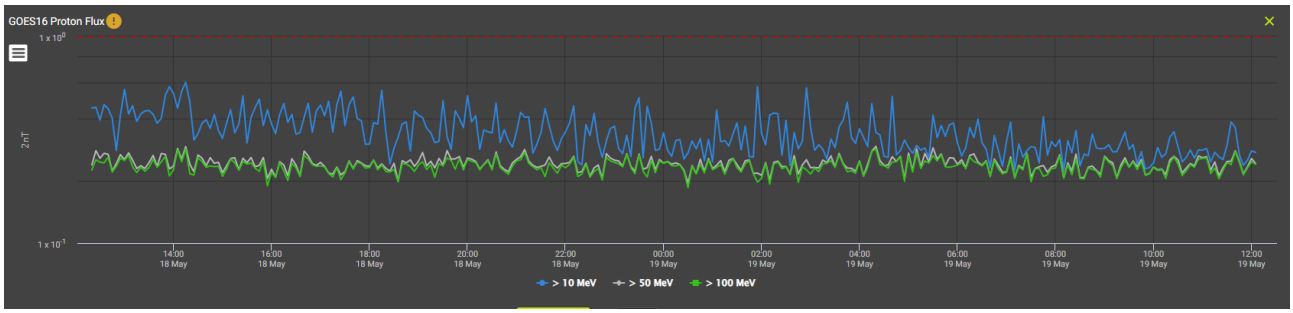
© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux, as observed by GOES16 is now gradually relaxing back towards Background levels, having been slightly enhanced in the wake of the M9.6 flare from 16 May.

AR3310 and AR3311 are currently the most likely sources for any further enhancements, and to a lesser extent AR3305. The risk of high energy proton events is therefore not negligible and increases slightly through the period, as AR3310 and AR3311 transit further west across the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Latest GOES-16 Proton flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has remained at normal Background levels over the past 24 hours.

There is only one possible source of fast wind in the four-day period, CH05/-, with its associated fast wind expected at the end of day 4. The minor coronal hole CH03/- is a recurrent feature however its influence was entirely masked by a CME-derived G4 during the past rotation and cannot be relied upon. The latest MOSWOC Enlil is most likely mirroring the arrival of the fast wind associated with the CME and the rise to 500-600 km/s is considered unlikely to happen before the end of day 4 (22nd). Any contribution from CH03 is most likely to remain modest, with high energy electron flux expected to remain at background levels.

The associated fluence is expected to remain below the Active (1e8 integrated flux) level throughout, the Met Office REFM model considered not to provide good guidance on this occasion.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.